THE TELEGRAPHIC JOURNAL.

VOL. III.—No. 65.

WEATHER-TELEGRAPHY.

EVERY science has in its time to pass through three stages before it can be considered perfect. There is first the stage of observation, when as many facts as can possibly be gathered together are duly marshalled in their proper order; next comes the stage of reflection, when theory steps in and adduces order from apparent disorder by explaining away the darkness hanging over these facts, and by unravelling the causes which have led to them; finally, there is the prophetic stage,—the phenomena of the past and present being satisfactorily accounted for, those of the future can be foretold with certainty.

There can be no question as to which of these stages Meteorology is in at the present moment. Many there are who would gravely doubt if it will ever get beyond the stage of observation, yet those who are best qualified to judge can entertain only one opinion upon the subject, and that is that our present ignorance and consequent wide-spread superstition with respect to it cannot last long. The weather phenomena must yield to that irresistible spirit of enquiry which never yet has failed in eventually surmounting whatever difficulties it has attacked. Thus Sir John Leslie, in his work on Natural Philosophy, says, "It cannot be disputed that all the changes which happen in the mass of our atmosphere, involved, capricious, and irregular as they may appear, are yet the necessary results of principles as fixed, and, perhaps as simple, as those which direct the revolutions of the Solar System. Could we unravel the intricate maze, we might trace the action of each distinct cause, and hence deduce the ultimate effects arising from their combined operation. With the possession of such data we might safely predict the state of the weather at any future period, as we now calculate an eclipse of the sun or moon, or foretell a conjuction of the planets."

To unravel this intricate maze by gaining possession of the data which are required, is the object of meteorology in its present stage. The initiative for this purpose in England was taken by the late Sir John Burgoyne, who as recently as the year 1852, proposed that land observations should be made by the Corps of Royal Engineers. Commodore Maury had been working at Washington for some time previously in the same direction, and the United States Government, on being consulted, expressed their entire willingness to co-operate in the scheme, and suggested that marine observations should be taken as well. Since then, the maritime nations have, one after another, taken up the idea, and throughout the whole civilised world at the present moment, not only are observers stationed at what have been considered to be the most advantageous points, but many of the steamship companies have lent their assistance to the work by allowing observations to be taken on board their vessels by competent observers with first-class instruments, and rendering these to the Meteorological Office upon their return.

To America belongs the credit of having been the first to suggest the employment of electric science, in the collection of these observations and in the utilisation of the results deduced from them when once obtained. As far back as the year 1846 we find Professor Redfield thus writing to the American Journal of Science and Arts: "In the Atlantic ports the approach of a gale may be made known by means of the electric telegraph, which probably will soon extend from Maine to the Mississippi." The idea thus originated was actually realised and carried into practical execution by Professor Henry and his assistants at the Smithsonian Institution between the years 1850 and 1855, and the subsequent impulse given to meteorology amongst the nations of Europe was unquestionably owing mainly to their exertions in this direction. In 1854 Le Verrier, in France, came to advocate the immense value of a system of telegraphic weather reports; whilst in 1861, in our own country, Admiral Fitzroy,—whose name will ever be inseperably associated with the science,—devised a code of meteorological telegraphy, instituted a regular service by means of which reports were received from various stations on the coast, and laid the basis of that weather study which, notwithstanding the innumerable difficulties it has to contend with, is day by day approaching a state of greater perfection. On the death of Admiral Fitzroy an able successor was found in Mr. Robert Scott, under whose direction the Meteorological Office in London is now conducted. Daily weather reports are there received by telegraph from no fewer than fifty-one stations, extending from Haparanda, at the extreme north of the Gulf of Bothnia, to Toulon, on the shores of the Mediterranean; from Christiansund, on the western coast of Norway, to Corunna, in the north-west corner of Spain, and including The Skaw, Wisby (the capital of Gothland), Paris, Biarritz in the S.E. corner of the Bay of Biscay, Sumburgh Head in the Shetland Isles, Valentia, Stornoway in the Hebrides, Hurst Castle in the Solent, &c., &c. The following particulars are sent from each of these at 8 a.m. daily:—The height of the barometer, the height of the thermometer in the shade, the direction and force of the wind, the amount of cloud, state of the weather, rainfall for the previous twenty-four hours and the sea disturbance. These are tabulated, and four charts, one for the barometer, another for the thermometer, a third for the wind and sea, and a fourth for cloud and rain, are drawn up from the data thus obtained, published and issued the same day. Incorporated with these are reports giving the same particulars at 2.0 p.m. on the previous day for nine stations.

Great as the service may be which electric science thus renders to meteorology in the collection of these observations, it renders a still greater practical service even now; and one which, as the science advances, will be more and more appreciated in giving timely warning of the approach of rough weather. For although no attempt has yet been made at a theoretical explanation of meteorological phenomena, there are certain valuable facts established from an observation of them. The motion and force of the winds, for instance, depend upon what has been named "the barometric gradient;" that is is to say, if there is a difference in the height of the barometer at any two places a

wind sets in between them with a force proportional to that difference; the area of depression again is found, as a generel rule, to travel eastwards at an average rate of about thirty miles an hour. Thus it is, that as most of the storms which visit us are first of all felt upon the western shore of Ireland, timely warning of the approach of these can be given to the seaports on the Irish Sea, the English Channel, the East Coast, as well as to France, and the eastern shores of the North Sea, all of which are warned of the expected approach of storms by our Meteorological Office.

The following statistics for the United Kingdom require no words added to them to show the good work done by our Meteorological Office in thus giving timely warning of the approach of nearly every serious storm to the seaport towns along the Coast:—

—	Warnings justified by subsequent Gales.	Warnings justified by subsequent Strong Winds.	Total Warnings justified.	Warnings not justified by subsequent Weather	Warnings late or partially late.
1870	46.7	21.7	68 4	22.4	...
1871	46.	17.7	63 7	23.	...
1872	61.	19.5	80.5	11.9	...
1873	45.2	34.	79.2	16.8	4 0
Totals for 1873	250	113	85	42	10

For this reason many suggestions have been made as to the best means of obtaining information of these storms on their easterly journey. The Portuguese meteorologists have proposed furnishing observations from the Azores by means of the cable, which touches there. This has been declined on the ground that no connection can be discovered between the movements of the barometer at Valentia, our most westerly point of observation, and the Azores. The storms which pass over these islands take a south-easterly direction towards the African continent, and do not seem to approach us. Equally valueless was the proposal to receive information from the United States, for the character of the storms becomes entirely changed after travelling over any considerable area of the earth's surface. The idea of placing large buoys as advanced points of observation off the Irish coast, and connecting them by wire with the main-land must likewise be abandoned until some means of anchoring these in such deep waters have been devised.

In another important respect electrical science brings with it valuable aid to the science of meteorology. No great meteorological change takes place without its being accompanied by marked disturbances in terrestrial electricity, either in the air, in the earth, or in both. And simultaneous observations of these disturbances carried out in different quarters of the world, and now for the first time rendered possible by the development of electrical science would place in our hands the only means by which we can hope to get at some definite understanding respecting them. The theory of lightning and thunderstorms is now fairly understood: the aurora borealis, it is generally accepted, is the result of electrical discharges through the rarified strata of our atmosphere, comparable in every respect to the passage of electricity through the so-called vacuum tubes. The earth currents, on the other hand, which are constantly flashing to and fro through the crust of our globe, but which at times appear with far greater violence than at others, are still unintelligible, and have in fact only of late years commanded the attention which they merit: the cause of the changes in terrestrial magnetism is likewise still wrapt in mystery.

Yet, notwithstanding the many barriers which stand in the way, "no philosphical mind," to quote the words of Dr. Whewell, "can doubt the fixity of these rules which are followed by the causes ever at work in producing those changes of winds and skies." And when the day does come, as come it inevitably must, when these are perfectly understood, only then can the aid which electric science has rendered be fully recognized.

ON A SYSTEM OF TELEGRAPHY.

A Course of Lectures, delivered at the School of Military Engineering, Chatham,

By W. H. PREECE, Member Inst. C.E., &c.

Lecture II.—A System of Telegraphy as applied to Commercial Purposes.

(Continued from page 213.)

We may take it for granted that in any invaded territory, where the commercial relations of its different localities have been conducted by telegraph, as is the case now amongst all civilised nations, these telegraphs must be continued in operation by the invaders to maintain these relations for the supply of food and necessaries to the armies, and for the support of the populations. It was so in France. The Germans had to invade all the occupied Departments with their telegraph organisation, and under certain necessary military restrictions, a complete commercial system was maintained. Hence it becomes necessary to discuss a system of telegraphy in its application to commercial purposes.

The same outcome of experience, the same process of natural selection, the same operation of the principle of the survival of the fittest, which have characterised the establishment of a railway system, are to be observed in the formation of a commercial system of telegraphy in England.

I pointed out in my first lecture that the first use of the electric telegraph in England was to facilitate the movement of traffic on railways. Prior to 1844, several short lengths of telegraph were erected upon different railways for this purpose, but it was in 1844 that the first line of any length was constructed, which was from London (Nine Elms) to Gosport, upon the London and South Western Railway. It was in reality erected under the auspices of the Government, for the Admiralty undertook to pay £1,500 a year for 20 years, and £1,000 a year for a further 20 years, for the maintenance of a double needle telegraph, for their own purposes, between Whitehall and Gosport and Portsmouth. The railway company

found the capital, and Messrs. Cook and Wheatstone carried out the work. In 1846 a company was formed to purchase the interests of Messrs. Cook and Wheatstone, and to establish a commercial system of telegraphy. The railway companies generally had begun to learn the advantages of the telegraph. The telegraph company undertook the erection and maintenance of wires, and by agreement, mutual arrangements were made by which the service was performed by the telegraph company. All the principal railways were rapidly fringed with wires. The service being a joint one the same wires conveyed both public and railway messages. The commercial prosperity at first was very poor; the returns were very small, and the prospects of the speculative shareholders very discouraging. In the year 1851, although 198 stations were open to the public, the total number of public messages sent during the twelve months was only 48,490. Ten years later they reached 2,676,354. As the public messages increased, they interfered so much with the service messages on the railway companies' business, that separate wires had to be erected for the public traffic, so that the principal centres of manufacture became connected with London by purely commercial wires, and similarly as the necessities of the railway service increased, it was found advisable to maintain wires purely for railway purposes. Hence, gradually two distinct systems began to form themselves side by side—the commercial system for public messages, and the railway system for the transaction of railway business proper. In 1870 these two systems became totally separated and rendered perfectly distinct from each other by the assumption of the commercial telegraphic business of this country by the State. In fact the time had come for such a step. The natural consequence of great commercial prosperity had shown itself. Rival and competitive companies sprang up to share with the successful introducers of commercial telegraphy their well earned profits; competition and emulation stepped in with all their beneficial advantages to the business section of the public, but at the same time carrying with them all their unprofitable results to a too confiding investing public.

The railway companies had found the necessity of distinct systems of their own for the furtherance of their own business, and the general public began to find that telegraphs were not useful for speculation alone but were adapted to play a far higher and more national object. The wires have now become the vehicle of communication as much for our little household joys as for the great concerns of state. The telegraphs belong to the nation, and every person has an interest in their wellbeing and welfare.

Year.	Miles of Wire.	Number of Stations.	Number of Messages.
1851	7,303	192	48,490
1862	57,879	1 616	2,676,354
1873	105,572	5,560	17,103,844

In 1849 there were but eight instruments at the head telegraph office in London, worked by four or five boys, there are now 436 instruments, employing 682 females, and 761 males, 1,443 in all. In 1852 it was mentioned as an extraordinary fact, that 1,000 messages passed through this office in one day. On August 1st, 1863, there were no less than 31,455, not including press work, which amounts to about half a million words every 24 hours.

The enormous development of telegraph business since the transfer to the State is due not only to the reduction of the tariff, but to the extension of the system to those numerous small post offices which private companies based on commercial principles could never have reached, to the increased facilities offered to the public, and to the improved manner in which the messages are transmitted as regards rapidity of despatch and accuracy of transmission.

I can remember the time when messages cost 6d. and 8d. *a word*. They are now less than three farthings. Addresses are sent free, occasionally much to the discomfort and loss of the postal department For instance, a message was sent from Sherborne, and delivered to "Jim Pierce, a little boy in charge of a horse and gig in a field called eight acres just above railway station, belonging to Mr. Giles Farrington Gurney." Another was to "F. T. Gleeson, a young American gentleman visiting the Tower of London, care of the presiding officer, London Tower. N.B.—Has peculiarly curly hair." Both were delivered. Another was addressed and delivered to "two ladies standing on the steps of the Royal Exchange."

The earlier telegraphs were all erected overground upon the railways. The mutual understanding existing between the first telegraph company and the railway companies facilitated this arrangement. The wires were carried into the towns underground. In a few exceptional instances only, where railways did not exist, poles and wires were carried along the roads by the side of the canals or across the country. But when rival companies sprang into existence, desirous of establishing communication between great centres of commerce already connected by the first telegraph company in possession of the railways, they were forced to take possession of the roads and canals. Hence when the telegraphs passed into the possession of the State, two great systems were found to be in existence—the one occupying the railways, and the other the roads and canals.

Owing to the opposition which the railway companies offered to the Bill to acquire the telegraphs in its passage through the House of Commons, a compromise was effected with the companies by which they retained the maintenance and management of the telegraphs on the railways, whether they were employed for postal or for railway work, but the road and canal lines remained in undisturbed possession of the Post Office. Hence there still remains two systems, the one—the road system, under the entire management of the Post Office; the other—the railway system, maintained by the railway companies, under the supervision only of the Post Office.

The relative advantages of road and railway wires are worth discussion, for the first question the telegraph engineer has to decide when erecting a telegraph is the selection of the best route. Although the first cost of the erection of a telegraph on a road is greater than on a railway, its subsequent maintenance under certain conditions is less. The principal condition is that the railway skirts the road so that they both run in the same direction, by which means access from one to the

other is easy. We thus obtain the conveniences and facilities of the road together with the conveniences and facilities of the railway. Under such conditions, carriage of stores is simple, the supervision of the line is more perfect, for the fact that the poles run along the side of a road induces better inspection. The inspector cannot help closely inspecting every wire and insulator. Little imperfections are easily detected and removed before they have time to become injurious. Prevention is better than cure at all times, and more especially so in a line of telegraph. The road man must walk his length. Even if he begs a ride he cannot go too fast to inspect his wires. It is not so on a railway. Walking is very difficult and it is neglected. The railway man contents himself with the train, from which close inspection is impossible.

The reparation of faults is speedier upon roads than upon railways. The road man is able to start after a fault *at once*, while the railway man has not only to wait for the starting of a train, but has frequently to pass the fault, and has to return to it many miles on foot. Hence experience proves that wires on roads are better maintained than those upon railways, the number of faults is less, and their duration not so great. It is generally assumed that a road line is more liable to wilful damage than that on a railway, but experience does not confirm that assumption. Insulator breaking is one evil which is met with on roads, but it has been considerably checked. Cockshying is a very healthy and amusing pastime, but it is speedily cured by immersion in a lock-up.

Each telegraph company as it sprang into existence was projected principally to utilize the patents of different inventors. Thus the original electric telegraph company acquired Cooke and Wheatstone's Patents. The British Company worked Highton's Patents; the Magnetic Company worked Henley's and Bright's Patents; the United Kingdom Company acquired Hughes' Patents; the Universal Company used Wheatstone's later patents, &c. Each company acting on its own experience had determined the best form of apparatus for its own purposes. Many kinds had been jostled out of existence by more fitting opponents, but there still remained many varieties. When all these companies passed into the possesion of the State, it became a subject of grave consideration to determine which forms of apparatus should be selected from the variety at the disposal of the department.

The form of instrument to be employed, expressly in a commercial telegraph, is a point of fundamental importance. Telegraphy does not convey ideas *directly* by signs or symbols, hence it is not a language. It merely transmits to distant points the first elements of a *written* language by certain preconcerted signals. Letters or numbers are indicated by signals which are either *visible* or *audible*. The visible signals are either transient or permanent and differ in *form* or *duration*. The audible signals are necessarily transient, and they differ in *tone* and *duration*.

The earliest form of an electrical instrument devised was one which indicated directly the letters of the alphabet by five pointers, but that first introduced into commercial use was the double of Cooke and Wheatstone, whose inventions the first electric telegraph company was projected to utilise. The needle telegraph is based on Romagnosi's discovery of the mutual action of a current and the magnet. Its signals are visible, transient, and different in form. The alphabet is formed by the vibrations of two small movable pointers or needles between two fixed spots. Two wires are required for its use, one of these wires so frequently failed that a single needle alphabet speedily shaped itself. Hence the practical teaching of actual experience reduced the *five* needle instrument first to *two* needles and then to *one* needle. The double needle instrument is now an instrument of the past, there is but one left in the Postal Telegraph Department, and it is gradually being replaced on the railways by the more convenient single needle. The single needle is a very useful form of telegraph. It is exceedingly simple in its construction, it is little liable to get out of order, it requires no adjustment or alteration of its parts to meet the varying changes of the weather, and its manipulation is easily acquired. Its chief advantage for railways is the fact that numerous instruments can be inserted on one circuit. Hence all the small intermediate stations of a long line can be served by one wire. Indeed it being the fittest for railway purposes, it has survived all other forms, and it remains essentially a railway instrument.

The tendency of improvement has been to lighten all its parts, and to increase its rate of working. The earlier double needle instrument only averaged *six* words per minute, but upon the later forms *forty-five* words per minute were easily attained by experienced manipulators. Even the single needle attains *thirty-five* words per minute. Hence wires which in the earlier days could convey only *six* words now transmit *seventy* words per minute.

The lessons of experience are admirably shown in the variations which the form of this apparatus and its parts have undergone during its existence of a quarter of a century. I can conceive no better way of instruction in the relative advantages and merits of different forms and parts of an apparatus than an examination of the different stages of its life; and I think that every telegraph school should be supplied with different specimens of each instrument in the various phases of its creation.

In America Morse had invented his recording instrument with its dot and dash alphabet, in fact a telegraph with visible signals, permanent in their character and differing in their form. The permanent marks were embossed on paper by the attraction of an electro-magnet upon its armature forcing a style against the paper strip. It only required the use of one wire and the operators were able to write for themselves. The needle instrument required a writer, unless indeed satisfaction was felt with reduced speed, for on the needle instrument, if a clerk has to read and write for himself, he has two operations of nearly equal duration to perform, the one to read the word and the other to write it down, hence the speed of working must be reduced one-half. Bain, in England, in 1846, invented an instrument similar to that of Morse, which recorded its dots and dashes by the precipitation of Prussian blue upon chemically prepared paper on the passage of the currents through it. This latter form was adopted in England in preference to Morse's original form, but about 1862 it was supplanted by the true

"Morse," which was less liable to get out of order, and which avoided the troublesome operation of preparing paper chemically, and which has recently been still further improved by supplanting the embossed paper with a pen, which records its character in ink.

This later form of apparatus is in very general use throughout Europe, but it is not the fittest, and it will probably not survive other forms which are developing themselves.

The speed with which an instrument works is usually registered by the *number of words* it can transmit in a *minute*, but owing to the regularity with which messages retain their average number of words, *the number of messages* transmitted *per hour* is now the usual criterion. Messages average 35 words, and words average 4·5 letters. Hence roughly, half the number of messages per hour equal the words per minute. The earlier Morse could not exceed six words per minute, but the rate at which the instrument now works on short circuits is simply the rapidity with which the operator can manipulate his key; 70 messages per hour are frequently obtained by experts, but it is difficult to maintain such a speed. The human machine tires, errors occur. His manipulation loses clearness and legibility. Bain invented the automatic apparatus to replace the human machine by a mechanical contrivance. This secured precision in the formation of the characters, accuracy in the despatch of messages, and speed in the transmission of work. There were, however, defects in Bains' apparatus, and automatic telegraphy was not a success until Sir Charles Wheatstone introduced his beautiful apparatus which is now in such extensive use, and without which it would have been impossible for the Postal Telegraph Department to meet the requirements of the press.

(To be continued.)

THE electric telegraph system is still in its infancy, and although its operations are marvellous, yet it is probable that we are at present but imperfectly acquainted with the full extent of its advantages. In this country the telegraph wires are simply used for the transmission of messages, but to Armenia belongs the honour of discovering that they may be adapted as clothes-lines for laundry purposes. The practice of hanging linen to dry on the wires has lately become general in that country, and revealed the hitherto unknown fact that the Armenian peasantry are in the habit occasionally of washing their clothes. Much dismay has, however, been caused by an order that has been issued by the authorities forbidding the continuance of this arrangement. It seems that the wires have on more occasions than one been broken by awkward washerwomen, and Shefket Effendi, an Armenian Scudamore, who has just been appointed director of the telegraph at Erzeroum, has solemnly declared that no more shirts, stockings, or other garments shall be hung on the wires on any pretence whatever.

PROFESSOR CORNU, of the *Ecole Polytechnique*, Paris, has put into successful use a new instrument for measuring the velocity of light between two stations, in which an electrical registering apparatus is used, giving, it is believed, more accurate measurements than the well known toothed wheel arrangement of Fizian. Foucault fixed the velocity of light, by his instrument, at 185,157 miles per second. Professor Cornu, by his new instrument, fixes the velocity of light at 186,660 miles per second, 1,503 miles faster per second than Foucault.

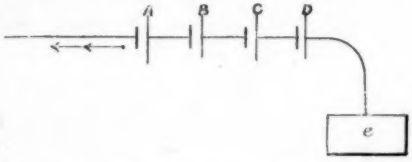
ON THE TELEGRAPHIC PROBLEMS OF DOUBLE SENDING AND QUADRUPLEX TELEGRAPHY.

By G. K. WINTER,
Telegraph Engineer to the Madras Railway.

(Continued from page 219.)

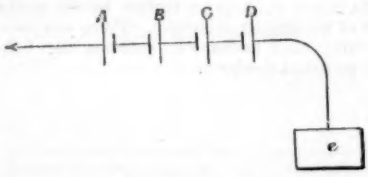
There are several ways of accomplishing this; perhaps the best is as follows:—

Let us suppose the full battery to consist of four cells (any multiple of that number would do as well). Let us represent them thus:—



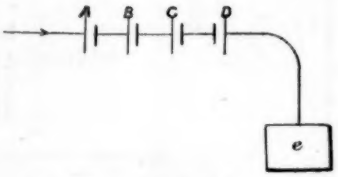
Let this be supposed to give two units of copper current to line.

Now suppose one of them, A, to be reversed by a reversing key, we shall have—



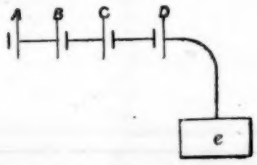
thus A and B neutralize each other, and we shall have one unit of copper current to line.

Next let us suppose A B and C to be reversed by the depression of the other key, then we shall have—



or one unit of zinc current to line.

Lastly, let us suppose both keys depressed, then A, which is reversed by the first key, will be set right again, and we shall have—



or B and C will neutralize A and D, and we shall have no current to line.

The following figure is a conventional mode of

representing the action of reversing keys, and will doubtless be understood.

r and r^1 are adjustable resistances, and I think the rest explains itself.

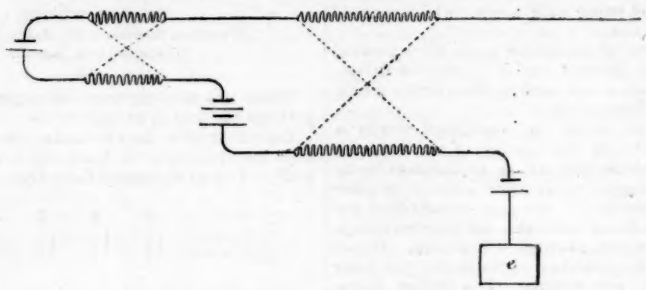


FIG. 8.

The sinuous lines show the connections when the keys are at rest, and the dotted lines shew them when they are depressed.

We have now to show how this system may be made into a quadruplex system by the application to it of the duplex principle. There are two ways of doing this, perhaps in practice the following will be found the best:—

With regard to adjustments, let a galvanometer G be inserted as shown in fig. 9, request the distant station to depress his key B, then adjust r until depressing either of your keys makes no alteration in the deflection of your galvanometer. This being done, adjust r^1 until the deflection itself becomes nil.

There are two or three obvious modifications of

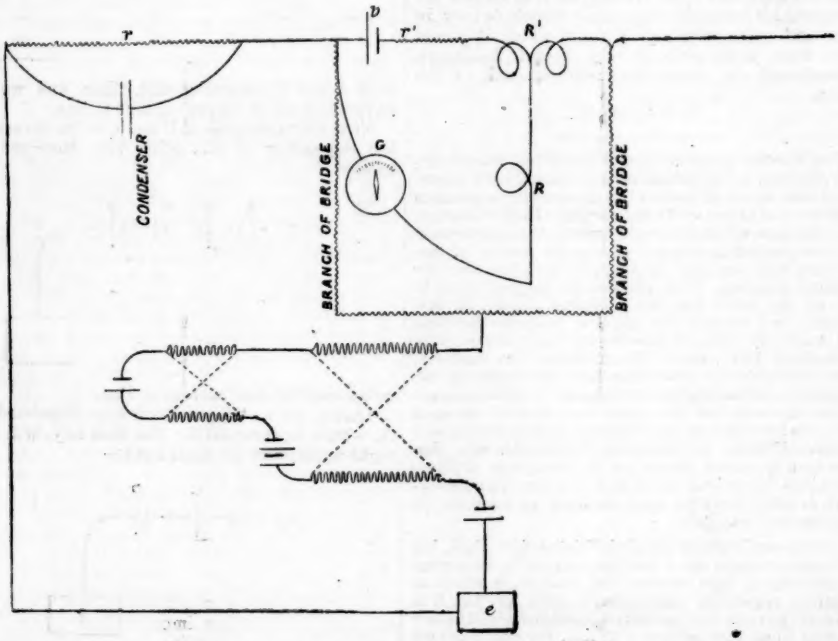


FIG. 9.

the arrangement of the receiving apparatus. For instance, we may connect the two relays one after another in such a way that the tongue R will be worked by a copper current from the distant station, while those of R^1 are worked by a zinc current, and then having the local battery connected through extra coils wound on the relays, and in each case tending to cause the tongues to make contact with their respective contact points; or we may abandon the local battery altogether, and substitute a bias in favour of making a signal by the adjustment of the position of the tongues between the poles of the electro-magnets. We sacrifice, however, by these modifications, the very simple means of adjusting the arrangements which we have just described.

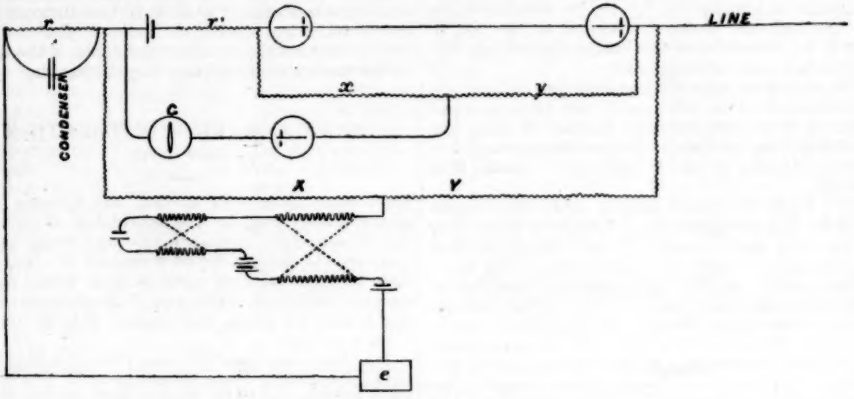


FIG. 10.

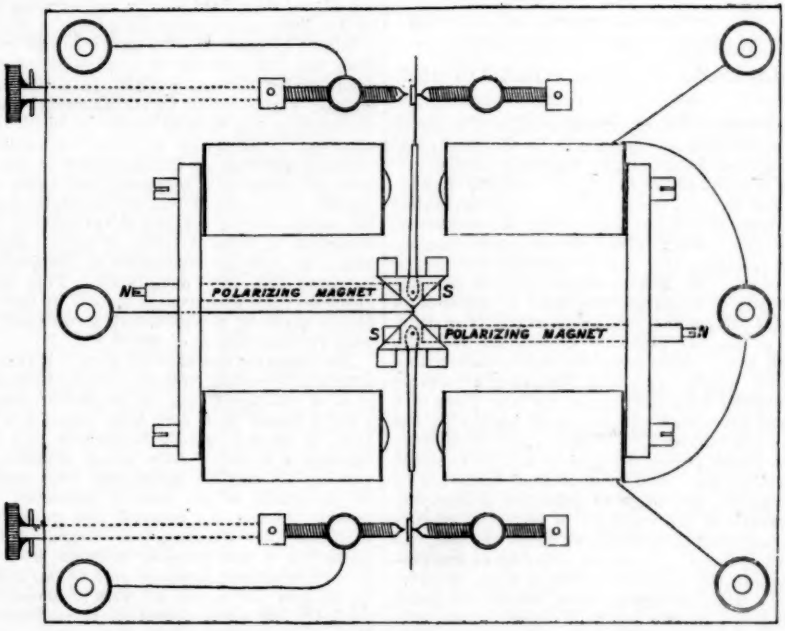


FIG. 11.

The following is a modification, however, which will probably prove an improvement in some respects. Instead of winding the relay R^1 differentially we may substitute the Wheatstone bridge principle, and further, we may use two distinct relays instead of one relay with two tongues. This

modification will enable us to place the two relays by means of which signals are produced upon Morse A, near that instrument, so as to be kept in adjustment by the clerk attending to it; while for the same purpose the other relay may be placed near the Morse B. The arrangement under this modification is shown in fig. 10, in which x and y are the branches of the last-named bridge, and X and Y the branches of the bridge for making the system a duplex arrangement.

We may also, even while using two distinct relays instead of a relay with two tongues, wind each of them differentially instead of using the branches x and y, but the bridge arrangement has certain advantages which leads me to prefer that system.

The form of double tongue relay that I have used for this arrangement is simply an adaptation of the relay used in applying my duplex method to intermediate stations. It is shown in fig. 11.

The double sending arrangement described in this paper has been worked with perfect success between Salem and Madras, on the Madras Railway, a distance of 206 miles. The arrangements for quadruplex working are not yet completed, but feeling sure, that having proved the success of the double sending, the success of that system worked in duplex may be taken for granted. I have not thought it advisable to delay this paper until the quadruplex system was in actual operation.

APPLICATION OF THE MAGNETIC NEEDLE IN SEARCHING FOR IRON ORE.

THE discovery of a considerable portion of the new mines in Sweden has been due to the facility of observing their action on the magnetic needle.

From the *Journal de Physique*, we learn that M. Thalen has recently conceived the idea of employing the magnetic needle not only to find the existence, but also, to a certain extent, the strength or quantity, the direction and depth below the surface, of masses of ore. M. Thalen effects this by measuring the intensity of the magnetic action, or rather of its horizontal component, at a series of points as near, and at as regular intervals as possible over the supposed mine. This measurement is made with a declination needle, and with the aid of a movable magnet which the observer can, at will, place in a fixed and invariable position with regard to the needle, or to remove it. At each point of observation, the needle is first brought to zero, the magnet being withdrawn. The magnet then being placed in its position, the angle of deflection is observed. The measure of the intensity of terrestial magnetism, comprising that of the ore below the soil, can be easily deduced. A certain number of observations enable the observer to trace lines of equal intensity, called *isodynamic lines*, which are found to be disposed in two series of closed curves, surrounding with greater or less regularity the two points, which correspond to the greatest and the least deflection of the needle. Between these two series of lines is a line not closed, called the *neutral line*, and which corresponds to points where the the magnetic influence of the mineral is *nil*.

The conclusions at which M. Thalen has arrived, are:—The line which joins the maximum and minimum, and which may be taken as the magnetic meridian of the mine, indicates the general direction of the ore. The intersection of this line with the neutral line denotes the point at which it is preferable to commence operations. And, lastly, the distance from this latter point to that of the magnetic meridian of the place, for which the deflection is minimum, gives half the distance from the centre of the mass of ore to the surface. These two latter results are only applicable, if the depth of the ore under the surface is considerable.

ON TELEGRAPH CONSTRUCTION.

By JOHN GAVEY.

IRON wire, as is well known, has hitherto been almost wholly used for the conductor of an open line of telegraph. Although offering a much higher resistance to the passage of a current of electricity than a copper wire of equal section would do, its superior tensile strength, and its cheapness as compared with the latter, have caused it to be universally employed.

It is very important for many reasons that iron of a good quality alone should be used, hence wire specifications generally contain very definite stipulations as to the tests which it should withstand with success. Hitherto none but its mechanical qualities have been regarded, it being doubtless considered that the difficulty and expense involved in the electrical testing of long lengths of iron wire, would be greater than the advantage to be derived from the introduction of a standard of electrical conductivity for each gauge. Iron like all other metals, varies much in its electrical resistance, according to the state of purity in which it may be obtained. Inasmuch, however, as uniform mechanical qualities are insisted upon in purchasing wire for telegraph purposes, and these qualities depend, to a great extent, on the state of purity of the metal, the per centage of variation in the conductivity of various lines, is not so great as it might be, were the conditions of the contracts less stringent than they usually are. That the resistances do vary, however, is shown by the different results given by wires erected at different periods with varying classes of metal.

The manufacture of iron wire is a very simple, but very interesting process. In the first operation—that of rolling—a bar of malleable iron, about 2 feet 6 inches to 3 feet long, raised to a welding heat, is passed rapidly backwards and forwards through a series of rolls which contain grooves, varying by regular increments from three inches to one-fourth of an inch in diameter. At each passage the iron bar becomes less in diameter and increases correspondingly in length, until in the course of a few seconds it issues from the last groove, whence it is wound on a drum, and appears in the form of a coil of wire of somewhat large gauge. The whole operation is performed at one heating of the original mass.

The wire in this state is hard and brittle, and the next process is that of annealing. To effect this the coils of wire are enclosed in a kind of air-tight furnace, in which they are exposed to a considerable temperature, then cooled gradually. They are thus rendered soft and pliable and are in a fit state for drawing.

The drawing is a very simple operation. A

number of plates of steel perforated with conical holes are fixed vertically on convenient benches, opposite to which are revolving drums of iron. A coil of the rolled annealed wire is taken, one extremity by a few dexterous blows with a hammer is reduced sufficiently in size to admit of its passing through the first hole in the draw-plate; it is then seized by a pair of tongs attached to the drum, which latter being put in rapid motion, the wire is drawn through the plate, and reduced to a uniform diameter, equal to that of the hole through which it has passed. This operation is repeated as often as is necessary, using smaller gauge draw-plates successively until the requisite size of wire has been obtained. For telegraph purposes the wire is annealed after the drawing is complete.

The final operation is that of galvanizing. To effect this the iron is first thoroughly cleansed in a caustic lye, to remove the grease which adheres to its surface in drawing. It is then immersed in a bath of *pickle*, composed of hydrochloric and sulphuric acids, to remove all traces of oxide, and to leave a chemically clean surface. After being washed in pure water to remove any adhering acid, it is finally passed through a bath of melted zinc, the surface of which is covered with ammonium chloride. The zinc unites with the clean surface of the iron, and on emerging from the bath, the wire is run through a bank of sand, which cleans off the superfluous zinc, and leaves that smooth bright surface which new galvanized iron presents.

Galvanized iron is invariably used for telegraph purposes in England, although in some countries plain iron wire is employed. The preservative action of the zinc covering arises from the formation of a coating of zinc oxide on its surface. Being insoluble in water, this coating protects the remainder of the zinc, and consequently the iron from further oxidation. In smoky places, however, the sulphuric and other acids, which are developed by combustion, attack the oxide and form sulphate or other like salts of zinc. These salts being soluble, are washed off by the first shower of rain, and a fresh surface of zinc is exposed to like influences, the result being that the whole of the coating is rapidly destroyed, and the oxidation of the iron of course follows. For such localities the wire is frequently protected by being coated with hemp or tape saturated with bituminous compounds. A simple application of coal tar, followed by dusting over the wet surface with clean sharp sand has been found effective; the difficulty with this is, however, to keep the protecting covering unbroken, for at all places where the metal is exposed rust sets in, which ultimately causes a break in the wire.

A compound conductor, consisting of a steel wire, covered with copper, has within a few years been used in America. A high conductivity with small bulk, and consequently, diminished strain on all supports is thereby attained. But little experience of its value in this country has yet been obtained.

The size or gauge of wire is denoted by numbers which correspond with various diameters. These numbers are entirely arbitrary, and several gauges are in use. That most commonly employed in this country is known as the Birmingham wire gauge. The following table, extracted from Mr. Culley's well known "Handbook of Practical Telegraphy," gives valuable information as to the section, weight, and breaking strain, of various sizes:—

IRON WIRE.

Birmingham Wire Gauge.	Diameter.	Area of Section.	Weight of 100 yards.	Weight of 1 mile.	Breaking Strain.	
					Hard wire.	Soft wire.
	inches.	sq. inch.	lbs.	lbs.	lbs.	lbs.
00	0.363	0.103	102.00	1,794	8.600	6.000
0	0.331	0.086	84.72	1,490	7.100	4.750
1	0.300	0.071	68.75	1,210	6.000	4.000
2	0.280	0.062	59.90	1,054	4.850	3.400
3	0.260	0.053	51.65	909	4.000	2,900
4	0.240	0.045	44.00	775	3.400	2 500
5	0.220	0.038	37.00	651	2.950	2.200
6	0.200	0.031	30.56	538	2.500	1.800
7	0.185	0.0265	26.15	461	2.200	1.520
8	0.170	0.023	22.10	389	1.750	1.200
9	0.155	0.0195	18.36	323	1.500	950
10	0.140	0.016	14.97	264	1.200	820
11	0.125	0.125	11.95	211	820	650
12	0.110	0.010	9.24	163	710	510
13	0.095	0.0071	7.05	124	640	400
14	0.085	0.0057	5.51	97	510	350
15	0.075	0.0044	4.29	76	410	300
16	0.065	0.0033	3.22	57	350	200
17	0.057	0.0026	2.48	44	280	150
18	0.050	0.0020	1.91	34	200	115
19	0.045	0 0016	1.55	27	150	85
20	0.040	0.0013	1.22	21	110	65
21	0.035	0.0010	0.94	17	85	50
22	0.030	0.0007	0.69	12	65	40

On account of the indefinite and varying sizes, which frequently correspond with certain gauge numbers, the diameters of wires are often given in decimals of an inch where accuracy is desirable.

In preparing specifications for telegraph wire, the following points generally are insisted upon:—It should be free from scales, flaws, splits, inequalities, cinder, and other defects, should be cylindrical throughout, and should conform within certain specified limits to the diameter ordered. Specimens from certain coils, either to be gauged with a decimal scale, or 10 feet lengths to be weighed, and the limits of variation to be defined. It should be highly annealed, soft, and pliable, and should stretch 18 per cent. without breaking. The wire should be manufactured in certain definite lengths, varying according to the gauge, which lengths should be entirely free from welds or joints of any description. Tensile strength and ductility to be specified. The former to be measured by the direct application of weights, the latter by gripping a certain length, say six inches between two pair of vice, and counting the number of twists it takes to break the wire. In this country it is customary to *kill* or slightly stretch wire before use. This is sometimes done in the factory by running the wire from one drum to another slightly larger in diameter, both being geared to revolve at the same axial speed. This removes all bends and kinks in the wire, giving it a smooth regular appearance, which not only improves the look of the line when erected, but causes a lesser liability to interruption from wind contacts. Flaws and bad places are likewise detected by the operation, which might otherwise pass unnoticed until they caused a fault through breakage when in actual

work. As a further means of revealing incipient defects the wire is frequently passed over and under a series of pulleys, by which splits and hard brittle places are revealed.

Notes.

THE ordinary general meetings of the Society of Telegraph Engineers will recommence on the 10th November.

It is stated that the President of the Society, Mr. Latimer Clark, will give the annual soirée towards the end of November.

Mr. W. T. Henley has offered his unsecured creditors 7/6 in the pound, payable at three intervals, but we are not aware of any arrangement yet having been come to.

The first section of the New Zealand Cable has left for its destination, it is expected the cable will be completed by February. Mr. W. Grigor Taylor, of the Eastern Telegraph Company, leaves shortly to take charge of the line

The half-yearly meeting of the Anglo-American Telegraph Company was held on October 1st, at the London Tavern, Bishopsgate; Lord Monck in the chair. The report stated that the total receipts from the 1st January to the 30th June, 1875, including a balance of £3,683 11s. carried over from the last account, amounted to £288,636 18s. 7d. The total expenses of the half-year, including income tax, repair of cables, and depreciation of cable stock, amount to £47,570 11s. 7d. One quarterly dividend at the rate of 5 per cent. per annum, free of income tax, was paid on the 1st May, 1875, absorbing £87,500, leaving a balance of £153,566 7s. from which a second quarterly dividend at the same rate of 5 per cent. per annum, amounting to £87,500 was paid on the 1st August, 1875, leaving a balance of £66,066 7s. (including £32,301 11s. surplus cable) to be carried forward to the next account. The falling off in the traffic receipts for the first six months in 1875, as compared with the corresponding period in 1874, amounting to £67,729, is to be attributed partly to the continued depression of the American trade, but chiefly to the reduction of the tariff to 2s. per word, which came into operation on 1st of May, 1875. This reduction, announced in the last report of the directors, and unanimously approved by the proprietors at their meeting in April, resulted in a considerable dimuninution of receipts. The hopes which were entertained by many that low rates would produce remunerative results have not been realised, for, although a large increase in the number of messages was obtained, the experiment, so far, seems to show, on the contrary, that a low tariff cannot produce a reasonable dividend. The report and accounts were adopted unanimously.

Information has been received by the Cuba Submarine Telegraphy Company (Limited), of the successful laying of the new cable of the International Ocean Telegraph Company between Key West and Punta Rassa, whereby uninterrupted telegraphic communication with the West Indies, Demerara, and Panama is again established.

The Eastern Telegraph Company (Limited) announce the payment on the 14th October of an interim dividend of 2s. 6d. per share for the quarter ended 30th June last. The registers of transfers will be closed from the 7th to the 14th October, both days inclusive. The company also announce that the coupons on the Six per Cent Debenture Bonds will be paid on the 15th October next at the bank of Messrs. Glyn, Mills, and Co., Lombard-street, E.C.

The half-yearly report of the Eastern Extension Telegraph Company has been issued. It states that the balance of profit amounts to £82,280 3s. 6d. An interim dividend of 1½ per cent. has already been paid, and the directors now propose a further distribution of 1½ per cent., leaving £22,355 3s. 6d. to be carried forward. The debenture debt has been reduced by £3,200, leaving a balance of £4,700. of which a further sum of £1,500 has been redeemed since the commencement of the present half year. The greater portion of the debentures authorised at the meeting in June last for the purpose of laying the cable between Sydney and New Zealand has been taken up, and this undertaking will be completed early next year.

It is announced by the Globe Telegraph and Trust Company (Limited) that the interim dividends for the quarter ending the 18th inst. will be 3s. per share on the preference shares, and 3s. per share on the ordinary shares, both payments being at the rate of 6 per cent. per annum.

The traffic receipts of the Western and Brazilian Telegraph Company (Limited), for the five weeks ending the 1st inst., were £10,360, showing an increase of £1,124 over the corresponding period of last year.

The Brazilian Submarine Telegraph Company (Limited) announce that the accounts show a profit for the year ending 30th June sufficient to enable the directors to recommend a final dividend of 2s. 6d. per share, making, with previous distributions, 5 per cent. per annum, and carrying to reserve the sum of £40,000.

The board of the West India and Panama Tele-

graph Company (Limited) will recommend to the shareholders at the approaching general meeting the declaration of a dividend of 7s. 6d. per share on account of arrears of dividend on first preference shares to 30th June, 1875.

We understand that the Silicated Carbon Filter Company, Battersea, have received an order from the Indo-European Telegraph Company, Kurrachee, for a supply of their largest sized filters, for use at the various stations along the route. Filters upon this principle have been in use for many years at the General Post Office in London, and they have also been adopted by the telegraph department and several other branches of the public service.

The Western and Brazilian Telegraph Company announce that their cable is interrupted between Santos and Santa Catherina. The breakage is in very shallow water, and their repairing ship being on the spot, communication by cable will be restored in a few hours. In the meantime telegrams for the south will be transmitted over the Brazilian Government land lines in operation between Santos and Santa Catherina.

The number of messages passing over the Cuba Submarine Telegraph Company's lines during the month of September was 2,072, estimated to produce £2,000, against 1,797 messages, producing £1,802 in the corresponding month of last year.

The traffic receipts of the Direct Spanish Telegraph Company, Limited, for the month of September, amounted to £1,547, against £1,245 last year.

The traffic receipts of the Submarine Telegraph Company for the month of September amount to £10,013, against £9,682 for the corresponding month of last year.

The traffic receipts of the Great Northern Telegraph Company for the month of September amounted to 392,089f., against 425,931f. last year; and the total traffic receipts from 1st January to 30th September were 3,186,948f., against 3,328,040f. last year.

The traffic receipts of the Eastern Telegraph Company for the month of September amounted to £30,176, against £28,208 in the corresponding period of 1874; those of the Eastern Extension, Australasia, and China Telegraph Company (Limited) to £48,080, against £18,163 in 1874; the Brazilian Submarine Telegraph Company (Limited) to £9,544, against £8,238; and the Direct Spanish Telegraph Company (Limited) to £1,547, against £1,245.

The Submarine Cables Trust announce that the coupons for the half-year, due on the 15th instant, will be paid as usual by Messrs. Glyn, Mills, and Co., on and after that date.

Within a few days of the opening of the Direct United States Cable, it was officially announced that it was interrupted. The fault is stated to be in shallow water off Newfoundland. The Faraday is expected to leave immediately in order to restore communication.

The working of the Direct was very good, and a high speed maintained. The Company claim to have delivered messages in New York in less time than the Anglo-American Company.

Immediately after this interruption the Anglo-American Company announced an increase in tariff to 4s. per word, which rate, it was stated would remain unaltered in the event of the Direct Cable being repaired.

It will interest our readers (says the *Indian Daily News*) to learn that "Quadruplex Telegraphy" (that is, the art of sending four messages, two in each direction, simultaneously, by means of one wire) has this week been accomplished on the Madras Railway Telegraph. The system which Mr. Winter, the telegraph engineer, invented in March last, proved perfectly successful on eighty miles of line, and its extension to lines of greater length is simply a question of additional condensers and battery power. The principle of sending two messages simultaneously in the same direction, on which this quadruple system depends, was successfully worked between Salem and Madras on the 16th of April last, but unfortunately other duties prevented Mr. Winter carrying out the duplexing of this principle until the last few days.

Since the nomination of Yaver Pacha as Director of the Telegraph and Postal Department and Mr. Scudamore's arrival, the postal and telegraphic administrations have displayed great activity. Yaver Pacha has introduced several important modifications in the interior postal service, and is now endeavouring to organize a daily mail for the rest of Europe, viâ Yaneonleon and Bucharest. There is every reason to believe that the Turkish administration will undertake the international service on the 1st January under the best conditions.

An interesting account of the preparation of the daily weather reports which are published in this and other journals is contained in the report of the Meteorological Committee of the Royal Society, issued with the Parlimentary papers yesterday. This committee is entrusted with an annual grant of £10,000 to cover the cost of the observations conducted under its direction. General Sir E. Sabine, R.A., K.C.B., is the chairman, and the services

of all the members, ten in number, are gratuitous. The office receives, or would receive, were the continental telegraphic communications and that with the Shetlands perfect, fifty-one reports every morning, and nine every afternoon, except on Sundays. The observations are taken on Sundays as on other days, but are not received at the Meteorological Office until Monday morning, when the report for Sunday is made out. The stations are situated along the entire coast of the Continent, from Christiansund, in lat. 63 deg. N., to Corunna, in lat. 43 deg., with four stations on the coast of the Baltic, and one at Cape Sicié in the Mediterranean. The system is unfortunately most defective along our own western coasts, owing to the imperfections of telegraphic communication in those thinly-peopled and mountainous districts. The only stations along the line in question are Valentia, Greencastle on Lough Foyle, Ardrossan, and Stornoway. The committee are not without hopes that they may be able to carry out the idea, proposed in their last report, of establishing a station at Mullaghmore, a low-lying point on the south side of Donegal Bay, not far from Sligo. The possibility of deriving benefit, as regards the probable weather of these islands, from constant reports from America, has frequently been inserted in the newspapers and in scientific journals, but the experience of the office, which for four years received daily reports free of charge from Heart's Content by the liberality of the Anglo-American Telegraph Company, is not favourable to the idea of incurring expense for such a service. Not only was little benefit derived from such isolated and unsupported reports, but the subsequent study of the weather recorded in ships' logs has shown that atmospheric disturbances, though they may cross the Atlantic occasionally from shore to shore, in most instances undergo such changes in their progress that the fact of the severity of a storm on the coast of America is no gauge of its probable character when it arrives on our shores. The daily observations are taken at 8 a.m., Greenwich time, and most of the telegrams arrive in London about nine o'clock, when the Intelligence Department of the Post Office extracts from them the portions required for its wind and weather reports. They are then at once transmitted to the office by the private wire. About two hours are required for their reduction, discussion, and the preparation of the daily weather report, copies of which are ready about 11 a.m., and are at once supplied for the afternoon issue of several of the London papers. A wind chart for the day is also drawn for the *Shipping Gazette*. A brief telegraphic resumé of the weather is despatched to the Marine Ministry in Paris, and, if necessary, telegraphic intelligence of storms or of atmospherical disturbance is sent to our own coasts and to foreign countries. Later in the day the foreign telegrams, and subsequently the afternoon reports, come in. The daily weather charts are drawn by noon, and forwarded to the lithographers to be printed, The copies for postal distribution are received at the office at about 3.30 p.m. The total number of copies issued every day is about 530.—*Daily News*.

Notice to Correspondents.

Mr. Fahie's solution of Mr. Edison's problem is quite correct. We have not seen Mr. Edison's own solution.

HOW IT FEELS TO BE STRUCK BY LIGHTNING.

Mr. A. Castle, a farmer in Whitewater, Mich., was recently struck by lightning, and thus describes his sensations:—As the storm came up, he says, he put his team in the barn, and sat down in the door facing the inside. A stroke of lightning which killed his horses and prostrated him did its work too swiftly to give him the slightest warning of its coming. His first remembrance, upon returning to consciousness, was hearing his daughter, who had run down from the house, about 25 rods distant, exclaim, "Oh! father is dead!" Upon opening his eyes, the whole air and sky seemed to be ablaze. He says the pain was like that of a burn, and that he could not have suffered more for the hour that followed if he had been held in the flames. His wife and daughter, upon seeing that he was still alive, desired to remove him to the house, but he begged to be left where he was and not to be disturbed, as he felt that he could live but a few minutes, and that he might as well die there as to be put to the needless torture of removal. As he seemed to gain strength, however, he was taken to the house and made as comfortable as possible, but eight or ten hours elapsed before he was able to move either of his lower limbs. The left hip and leg seemed to be more affected than the right, and the symptoms for a time indicated that the bones were injured. But these have passed away, and a slight lameness now remains. The right lung has been very sore since the occurrence, but this may have been caused by an injury received in falling. The mark of the lightning is apparent from the shoulders to the calf of the right leg, in the shape of a broad, irregular strip, from which the skin has peeled off as though it had been scalded,

A new telegram code has been compiled by Mr. George Ager, LL.D. (published by Williams and Co., Moorgate-street) for the use of bankers, merchants and shipowners. The code is written in accordance with the St. Petersburg Telegraph Convention, each code word not exceeding eight letters, and is intended for use privately as well as publicly, also providing a method for insuring the correctness of a message.

To Correspondents.

. Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Telegraphic Journal" is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the Editor; business communications to the Publishers, 10, Paternoster Row, E.C.